THE THINKING PROCESS

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PREFACE

The present chapters are intended to furnish to students of elementary psychology a study of the thinking process. Nearly all of the present day textbooks in psychology either omit entirely a study of the thinking process, or treat it very inadequately, on the ground that logic is a separate science. Whether it is a separate science or not, a knowledge of logical processes is an essential element in the preparation of a teacher; and since few normal schools offer a separate course in logic, whatever knowledge of logical processes is acquired must be obtained from the course in psychology.

In the present chapters an attempt is made to bring the processes of the old formal logic into harmony with the most advanced development of functional and physiological psychology. That all mental functions are capable of reduction to such processes as will render a uniform treatment possible, is an article of faith with all psychologists; but up to the present, it has not seemed possible to give to the thinking processes a physiological and biological interpretation.

Ypsilanti, January 2, 1910.

CHAPTER I

THE LAWS OF ASSOCIATION.

So far as association stands for a cause, it is between proceesses in the brain.—*James, Psychology, Volume I., p. 554.*

The socalled law of contiguity proves to be resolvable into the law of similarity.—*Spencer, Psychology, Volume 2, p. 505.*

(In association) there is probably an increased closeness of connection between cell and cell which makes for a greater likelihood of recall for one when the other comes into consciousness. —*Pillsbury, Attention, p. 105.*

Aristotle recalled the laws of this connection (association) to four, or rather three; contiguity in time and space, resemblance, contrariety; he even thought that they might all be carried up to one, coexistence.—*Hamilton, Metaphysics, p. 424.*

These feelings (succession, similarity, coexistence) or their contraries are the foundation of everything that we call a relation. —*Huxley's Hume, p. 81.*

It had been assumed that when two groups of cells — the substratum of two images — are excited at the same time, the nervous wave circulates from one group to the other through those communicating fibers that are so numerous in the brain.—*Binet, Psychology of Reasoning, p. 185.*

Contrast, however, is only a special case of similarity. Only, and in fact, just those ideas contrast that differ in one point while they are similar in very many other points.—*Ziehen, Physiological Psychology, p. 207.*

The fundamental conception that all processes of thought can be reduced psychologically to the association of ideas will at all events endure.—*Ziehen, Physiological Psychology, p. 244-5.*

On the contrary we shall hold to the fact that all these activities (understanding, reason, power of judgment, sagacity, fantasy, etc.) simply represent varieties of the association of ideas. It would not be at all difficult to reduce all these forms to the one fundamental form of association by purely psychological reasoning.— *Ziehen, Physiological Psychology, p. 244-5.*

So far from association by similarity being resolvable into contiguity, every association by contiguity on the contrary presupposes an association by similarity, or at least, immediate recognition.—*Hoffding, Psychology, p. 157.*

From this point of view the association between part and whole would be the typical form of association. This fundamental law of all association of ideas might be called the law of totality.—*Hoffding, p. 159.*

Contrasts often belong to the same general conception; just as two poles are removed, each in its own direction, from a common center. Dwarf and giant both deviate from the ordinary medium height.—*Hoffding, p. 161.*

Whence we see clearly that the ultimate law of association of feelings as above described has a definite physical counterpart, and there is no room for any other law of association of feelings.—*Spencer, Psychology, Volume I, p, 258.*

What Association Is.—One idea succeeds another in the mind. It is impossible to retain one idea without variation for a longer time than about three-fifths of a second, and the whole series that follow one another is called a train of ideas, or a train of thought.

If we write down the nine words that occur to the mind after a first one has been suggested, we shall have a train of ideas. Suppose the first word is watch. The following nine words, or ideas, that follow may be gold, mine, men, women, dress, pretty, witty, funny, pun. We shall need to answer the question why each word instead of some other follows the preceding. Gold follows watch because there is a distinct relation between watch and gold which we may call the relation of object and material. Gold is the material out of which a watch is frequently made. Mine follows gold because of the relation existing between them. Mine is the source from which the material comes, and the relation may be called material and source. Men follows upon mine in consequence of a similarity of sound. Women follows men, because of a

relation of contrast. Also, we may notice that there is a similarity in sound in the final syllable of women. Dress is associated with women, and the relation is one that we may call contiguity. Pretty follows the word dress because of the fact that pretty is a quality of dress, The relation is one of substance and quality. Witty follows pretty, the relation being a similarity in sound. Funny is related to witty, there being a similarity in meaning. Pun follows funny, the relation being both one of similarity in meaning and in sound.

Laws of Association.—We see, then, that there is a reason for the fact that each word follows the one that preceded it, and that reason is the existence of a relation between them. We have stated several relations, and there are many more. These relations are called Laws of Association.

Older psychologists worked industriously to discover a complete list of the laws of association, and it was a very common occurrence for a psychologist to discover and formulate a new law. We see that to make a complete list of the laws of association is necessarily impossible, for there are just as many laws of association as there are relations that may exist between objects.

Some of the Laws.—Some of the laws of association that psychologists discovered were the following: Contiguity, coexistence, contrast, cause and effect, similarity, part and whole, substance and quality, material and source. Many others might be mentioned, but these will sufficiently illustrate the matter. When many laws had been discovered, then psychologists undertook to reduce them to a smaller number, or to show that all of them were forms of a single law. Considerable success attended their efforts, and some psychologists believe that

the law of contiguity might be made to include all of them. The law of contiguity is a statement of the relation between two things that have existed, or do now exist, in the same place. The law of coexistence is a statement of the relation between two things that have existed at the same time.

Others believe that the law of similarity would be sufficiently inclusive to cover all the relations, and still others that the law of part and whole, called the law of totality, might be sufficient. It does seem possible to reduce all laws of association to a single law, and it seems advisable to call that law the law of resemblance.

Definition of Each.—The law of contiguity means that there is a relation between two objects or events that have existed in the same place, such that when we experience the idea of the one it is likely to be succeeded by the idea of the other. Rome, Tiber, Vatican are related by the law of contiguity. So two students who have graduated from the Normal college are thus related, although one may have been a student in 1865 and the other in 1909.

The law of coexistence is a statement of the relation between two objects or circumstances that have occurred at the same time, such that when we experience the idea of the one it is likely to be succeeded by the idea of the other. The discovery of America and the invention of printing are two events thus related, for they occurred approximately at the same historical period. So two students of the Normal college who have attended school at the same time are related by the law of coexistence.

The law of contrast is the statement of relation existing between two things that are different, such that when the idea of the one is experienced it is likely to be followed by the idea of the other. The idea of a tall man

is likely to be followed by the idea of a short man. The idea of a cold day is likely to be followed by the idea of a warm one.

The law of part and whole is a statement of the relation existing between the part and the whole, such that when the idea of the part is experienced it is likely to be followed by the idea of the whole, or the idea of the whole is likely to be followed by the idea of the part. Thus the idea of a particular window of a house is likely to be followed by the idea of the whole house, and the idea of the blade of a knife is likely to be followed by the idea of the knife itself.

Reduction to the Law of Resemblance.—The law of contiguity may be reduced to the law of resemblance. Contiguity means that relation of existing in the same place, or contiguous portions of space. Two objects, events or circumstances that are related to each other by the law of contiguity resemble each other in the element of position, and there is the element of sameness of place in them. Two men who are students of the Normal College are botn alumni, or Normal College men, and they recognize a kinship with each other. Similarly the law of coexistence is a statement of the relation of resemblance, and two objects or events that coexist resemble each other in time. The resemblance is often much closer than this expression would suggest. Two students in the Normal College in the year 1909 resemble each other much more closely than does a student of 1909 resemble one of 1865. Two present year students resemble each other in manners, dress, habits of thought, subjects studied, topics of conversation, and in many other respects, much more closely than they resemble a student of 1865.

Reduction of the Law of Contrast.—It would seem that if we could reduce the law of contrast to a law of resemblance, we should be able to reduce every law to that form. But it is not difficult to show that two ideas of a contrasting pair are similar. The tall man is like the short man in the fact that both of them are different from the average man. But the resemblance goes deeper than this. They are both men. They belong to the same order of existence, and no contrast can exist between two things that belong to different orders of existence. There can be no contrast between the nominative case, and the horse power of an automobile. The law of part and whole is reducible to the law of resemblance. The part is like the whole, and the whole is like the part. A cupful of water is like the whole barrelful. The face of a watch is like the watch just in so far as it constitutes a part of the watch.

Reduction of the Law of Cause and Effect.—The law of cause and effect will seem much more difficult to reduce to the law of resemblance. Can we show that the cause is like the effect and the effect is like the cause? The difficulty comes from an indefiniteness in the meaning of cause. Philosophers are not at all agreed upon a definition, and until we have a satisfactory meaning for the word cause, we must expect to find difficulty in the management of the idea. But if we consider cause as being merely the force that is transmitted from the thing in which it exists to some other thing, whose change of position, movement or state is called the effect, we shall see that cause and effect are both forces, one of which is lost to the thing in which the cause exists and the other appears in the thing that manifests the effect. Force is the same, no matter in what form nor in what body it appears. Also, we might show that the law of cause and

effect is one form of the law of contiguity, for the effect must always be contiguous to a cause, or have some kind of immediate contact with it. But the law of contiguity is one form of the law of resemblance, hence the law of cause and effect must also be.

Mediate Reduction.—Sometimes it is necessary to reduce one of these laws to another and that other to the law of resemblance before we can show that all laws are capable of being thought of as forms of resemblance. It will be seen that the resemblance may exist in only one quality, and it is not necessary that all qualities shall be the same. If two things were to be the same in every respect, they would be identical, and instead of two, there would be only one. There can exist no relation then, without a difference. Resemblance depends upon and includes difference.

Simultaneous Association.—The illustrations that we have employed are those of successive association, and the result is a train of ideas. But there is another kind of association that may be called simultaneous association, in which the associated processes occur in the same pulsation of consciousness, or in about three-fifths of a second. Such an association is illustrated by the process of perception, in which the various sensations that constitute the percept occur together, or nearly so.

Exemplifies the Same Law.—A question may arise whether the qualities that exist in an apple and the sensations that enter into our percept or our idea of the apple are capable of being described in the same terms. Are the qualities of an apple or the sensations in our idea of the apple associated by the law of resemblance? Do

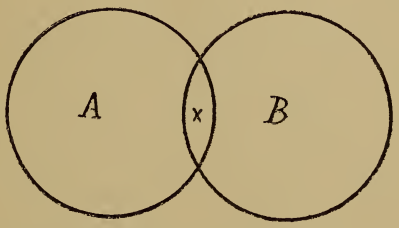
the qualities of an apple and the sensations that occur in our percept or in our idea of an apple resemble each other?

Resemblance the Only Law in Perception.—The sensations that enter into our idea of an apple appear together, all of them being experienced in the same pulsation of consciousness. It is not difficult to show that they are associated by the law of resemblance. In the first place, they are associated by the law of contiguity, which is one form of resemblance, and they are associated by the law of coexistence, which is another form of resemblance. Also, no one of these qualities or sensations is incompatible with the others, so there is the element of compatibility; and besides this, sensations that are experienced together modify each other, so that each one affects every other. In this manner we may think of each of them being cause and effect in relation to the others. So it is not difficult for us to understand that the different sensations that enter into our idea or percept are associated by the law of resemblance as truly as are the elements in a train of ideas.

Titchener's Formula.—Mr. Titchener describes a formula for association which represents the facts very nicely. He states it algebraically, thus: *ab—bc—cd—de—ef—fg—gh*—etc. Let *ab* be one idea consisting of several or many sensations, and *be* be another idea. *Ab* is likely to be followed by the idea *bc*, because *bc* is like *ab*, both having the common element *b*, in which the resemblance consists. So *bc* is likely to be followed by *cd*, because of the common element of resemblance *c*.

Angell's Figure.—Mr. Angell uses a different figure for association which is equally good. The figure consists of

two circles which intersect, and so have a common section which represents the element of resemblance. Call one circle A and another circle B and call the section that is common to the two circles x. When the idea which is represented by A is experienced it is likely to be followed by the idea B, because the idea B resembles the idea A in the common element x. The resemblance will be greater or less according as x is larger or smaller.



A and B represent two combinations of neurons. X represents the neurons that are common to the two combinations.

Physiological Interpretation of Association.—Let us try to think of these associations in physiological terms. We have already learned that when we are experiencing an idea, a nervous impulse is passing through some brain center. Let the circle A represent the brain center or combination of brain cells that is being traversed by an impulse when we are experiencing the mental process *a*, then the impulse passes out of the brain center A and into the brain center B which corresponds to the idea *b*. Now our question is why does the nervous impulse pass into *B* rather than into *C* or *D* or some other brain center? The answer is evidently that there is less resistance between A and B than there is between A and C or any other brain center. The fact of little resistance is indicated by the common section x. When the nervous impulse is

traversing the center A, it is already traversing some of the brain cells which enter into the constitution of B; so in effect it is already in the center B when it is traversing A.

Physiological Association Determined By Resistance.— It will be seen that the nervous impulse passes from the center in which it is at any time into that particular center that offers least resistance to its entrance. One idea will be followed by that idea which most closely resembles it, and we may recognize that the nervous impulse is directed by the resistance encountered. There is one modification of this rule which we must notice; that is that by a process of attention we may think of anything that we please, and are not compelled to depend upon accidental association. We may describe attention in physiological terms by saying that it is the process by which we may modify the resistance that a nervous impulse encounters, and so direct the nervous impulse into and through a brain center. This fact of attention must be taken into consideration in any discussion of association.

Association Centers Not Necessarily Contiguous.— We have been discussing the brain centers and their close relation to each other as if the centers were contiguous, and that this contiguity constituted the closeness of the relation, but such is not necessarily the case. A combination of cells in the occipital lobe may be more closely associated with a combination in the temporal lobe than it is with another combination in the occipital lobe. There are numerous bands of fibers, called association fibers, that connect different portions of the brain with each other. A nerve fiber offers little resistance to the transmission of an impulse, and when two portions of the brain are connected by means of fibers, they are

much more intimately associated with each other than two other centers which are connected only through neurons, or brain cells, with their insulating neuroglia.

Association Centers.—We have learned that the centers of sensation and of motion are pretty definitely localized in the brain. But when we have located as many areas of this kind as possible, we find that there are large portions of the brain in which no function is described. Four of these large areas, which we have recognized as unexplored areas, have been described by certain writers, provisionally at least, as the probable areas of the higher mental faculties. This implies that there are higher mental faculties than sensations and the association of ideas. Two of these areas are in the frontal lobes and two are in the parietal lobes. In them, various writers have located the functions of attention, memory, thought, apperception.

Flechsig's Investigations.—Flechsig has definitely located in these areas the function of association and has called them association centers. Haeckel has taken Flechsig's conclusions rather seriously, and has assumed that these really include thought centers, and has called this portion of the brain the thought portion, naming it the phronema. This seems to imply that there is a different portion of the brain involved in the experience of the idea of an apple from that which is traversed by an impulse when we perceive the apple. It implies that the functions of memory, reasoning, ideation, attention, and perhaps feeling, are located in particular places in the brain, and that there are higher processes of thought than those that are involved in the association. If we understand the process of association as we have inter-

preted it in physiological terms, we shall see that attention, memory, ideation, and thought are processes that cannot be localized in this way. It shall be our purpose to show that there are no higher processes of thought than those which are involved in these processes of association. Hence it appears that the assumption of Flechsig is entirely unnecessary, at least in the manner in which it is understood by Haeckel and others; and Flechsig himself has been compelled to modify his opinions very materially. We may not be able at present to determine what is the function of the unexplored areas, but there are many sensation areas that we have not as yet located.

Effect of Attention Upon Association.—We have already made the statement that attention can vary the resistance and so modify association. When attention is wanting, as in the case of sleep, then the nervous impulse follows the path of least resistance, as it is determined without attention, and we sometimes remember things that we have forgotten in our waking hours. The fantastic character of dreams may be explained in this way, and sometimes oncoming disease has been recognized, which was not noticed in the waking hours.

Imagination.—When ideas are associated, either by the process of attention or without it, that have not been associated in the original experience, we have the process of imagination. There is no brain center for imagination any more than there is for memory. Nervous impulses pass from one brain center that has been traversed before over into another that has been previously traversed, but over a different pathway from that by which the brain centers were entered in the original experience. If the attention is active and directing the impulse, we have

the condition of active imagination; if the attention is wanting, we have the condition of passive imagination, or day dreaming.

DEFINITIONS

Law of Association.—A law of association is a statement of the relation existing between two ideas that have been previously experienced, such that when one of them is again experienced, it is likely to be followed by the other.

Train of Ideas.—The succession of ideas that are associated by successive association.

Successive Association.—That kind of association in which ideas follow each other in successive pulsations of consciousness.

Simultaneous Association.—That kind of association in which the associated elements occur in the same pulsation of consciousness. It is illustrated by the process of perception, in which the associated sensations are experienced at the same time.

Relation.—In the most general meaning of the term it means any form of resemblance. It is the resemblance that one object or one idea bears to another object or to another idea.

Phronema.—As used by Haeckel, it means that portion of the brain designated by Flechsig as association centers. It consists of four large unexplored areas, two in the frontal lobes and two in the parietal, in which no function has been definitely located by psychologists.

CHAPTER II

THE FORMATION OF THE GENERAL ABSTRACT NOTION.

General notions are the shorthand of thought.— *Thorndike, Psychology, p. 116.*

We cannot, in fact, assert the existence of an difference without at the same time implying the existence of an agreement.— *Jevons, Principles of Science, p. 44.*

The end of philosophy is the detection of unity.—*Hamilton, Metaphysics, p. 366.*

It may startle you to hear that the highest function of mind is nothing higher than comparison, but I am confident of convincing you of the paradox.—*Hamilton, Metaphysics, p. 272.*

Since the process of reasoning is essentially a detection of similars, the great source of erroneous reasoning is the confusion of things that are not really and fundamentally similar; or in other words, a want of discrimination.—*Sully, Teacher's Handbook, p. 392.*

Coupled with discrimination, it (agreement) exhausts the meaning of what we call knowledge.—*Bain, Mind and Body, p. 86.*

The common features do not suffice to constitute an image. Just as we cannot eat fruit in the abstract, but only apples, pears. etc., so we cannot picture fruit in the abstract. But then, have we psychologically, really general ideas?—*Hoffding, p. 166,*

It has been shown that comparison is the fundamental form of cognitive activity at all stages of development. But that which is to be an object of comparison must be confronted with something else, either similar to it or different from it.—*Hoffding, p. 216.*

The Intellectual Process.—The intellectual process, as distinguished from the affective or other process, is one which results in knowledge. It makes us know something. A sensation makes us acquainted with the quality of an object. Perception is the process which makes us know an object, or the sum of all the qualities that we are able to discover in it. The percept is the sum of all the

sensations that we receive from an object, both faint and vivid, as they modify each other. We may obtain several vivid sensations from an object, each of which is the concomitant of a peripherally initiated impulse, and there may be more than an equal number of faint sensations, each the concomitant of a centrally initiated impulse. All the sensations join themselves together, the concomitant impulses become a single one, the sensations modify each other, and the result is a percept.

The Singular Concrete Notion.—We obtain by perception, knowledge of a single individual thing, and this percept we may call a singular concrete notion, whose expression is a proper noun. A proper noun, then, is the expression of a singular concrete notion. Very few objects that we have occasion to indicate have proper names, so we do not many times indicate them correctly. We ordinarily employ a common name with limiting words to indicate which particular thing we refer to. Only persons, dogs, horses, and some other things are ordinarily called by their proper names.

The General Abstract Notion.—A common noun is the expression of a general abstract notion. The general abstract notion, is the content or meaning of a common noun. The word concept is frequently employed to express what we shall understand by the term general abstract notion, but for our purpose the latter term is better. In order to understand how a general abstract notion is obtained we shall necessarily employ consciously a process which represents what actually occurs as an unconscious process in nearly every case. Let us suppose that we are intending to observe the process by which we obtain a general abstract notion of insect. We shall necessarily begin our study with an individual

insect, such as a grasshopper. The first thing we do is to look at the grasshopper as a whole, but this is not sufficient to give us a satisfactory knowledge of the grasshopper. Then we observe that the grasshopper is composed of parts, of which we readily discover, the head, thorax and abdomen. Now we fix our attention upon the head, to the exclusion, for the time being, of all other parts of the body. But we do not merely look at the head as a whole; we observe that it is made up of parts. We see the eyes, and fix our attention upon them, excluding for that instant all other parts of the head. We examine the antennae, fixing our attention for the instant upon one of them, excluding all other parts of the head. We count the segments of the antennae, and in the process of counting we are seeing just one segment of the antenna at a time, excluding all other segments and all other parts of the head. We count the segments, not for the purpose of finding out how many there are, although this knowledge will necessarily be obtained; but for the purpose of fixing our attention for the instant upon each single segment, to the exclusion of everything else.

Abstraction.—While we are thus fixing our attention upon one thing to the exclusion of everything else, we are engaged in the process, of abstraction. Abstraction is a very important process, and really a very difficult one. Our grammars usually define an abstract noun as the name of some property or quality considered separate and apart from the object to which it belongs, but this usually gives a poor idea of the process. It is just as truly a process of abstraction to consider the leg of a grasshopper, or the second joint of the antennae, to the exclusion of all other segments, as it is to abstract truth, redness, virtue, or any other property from an object.

Analysis.—The second process employed in the study of an object is analysis, which goes along parallel with that of abstraction, and in fact can scarcely be separated from it. Analysis differs from abstraction in the fact that it examines the relations that one part holds to the other parts. Our attention is focused, not upon the part itself, but upon the relation that this part holds to the other parts. We hear much of analysis in grammar and arithmetic, but the process is the same wherever we find it. In the analysis of the problems in arithmetic, we need to perceive the relation that one quantity in the problem holds to the other quantities. In the analysis of sentences in grammar we need to see the relation that one element in the sentence holds to the other elements. This process of abstraction and analysis is a necessary step in the formation of the general abstract notion, but it is all included in the study of the individual. The analysis that has been described may be called concrete analysis, for it is an analysis of an individual concrete thing.

Related Knowledge.—After we have obtained as thorough a knowledge as possible of an individual insect, we proceed to study in the same way other related insects. It will require not nearly so long a time to study a cricket as it did a grasshopper, and we shall be able to see just as many things and see them just as well in two hours on the cricket as we did in twenty hours on the grasshopper. This is not, however, because we have cultivated our observing powers, but because we have already a large body of knowledge by means of which we can tie up the new knowledge obtained in the study of the cricket. It is by means of this related knowledge that we are able to see so much more with the mind than we are with the eye.

Economy of Effort in Learning.—The process by which the acquisition of related knowledge is made is a process of discrimination and comparison. In learning new knowledge that is related to the old, we do not examine every element of the new, but we examine and learn as new only those elements in which the new differs from the old. The new elements may be a very small part of the old, and since in learning the new we have to learn only the elements that are different, we shall discover that there is a great economy of effort. If we suppose that there are ten elements in the old knowledge that we have learned, and that in the new which we wish to learn there are also ten, but only three of the ten elements are different, and seven are the same, we can see that it will require only three tenths as long to learn the new as it did the old. Hence it is wasteful expenditure of energy to learn anything as if it were unrelated to something else.

Physiological Interpretation of Economy in Learning.—This fact of economy in learning, and the process by which a new thing is learned by observing how it is like and how it differs from that which is already known, may be described in physiological terms. Let us suppose that the brain center A (fig. 1,) is the center that is traversed by one impulse when we experience the entire process of learning the first thing. Let us suppose that brain center B is the combination of cells that is traversed by impulses when we experience the new thing that is to be learned. Let us suppose that seven tenths of the cells in B are the same cells that are found in A, but that three tenths of B do not belong to A. The nervous impulse, having already traversed all the cells in brain center A will pass easily through that portion of B which is a part of A. The difficulty and resistance will be encountered

principally in that part of brain center B which is not found in A. Hence it is that the resemblance between A and B permits the impulse to pass readily through a large part of B. The effort of attention will then be devoted to driving the impulse through the portion of B which is not a part of A. The economy of effort in learning, then, depends upon the perception of the resemblance and the attention to the difference that the new thing bears to the old which we already know.

Order of Study.—Let us suppose that we have studied a butterfly, beetle, bumblebee, squash bug, dragon fly, housefly and grasshopper. The order in which they are studied is not a matter of indifference. Certain relations make themselves manifest if they are studied in one order which do not appear, or which are much less easily seen if they are studied in a different order. When we have studied the individuals of these kinds then we are ready for the next step. We need to notice the differences which have manifested themselves to us while studying the different insects, and we make a table such as is here represented. This table represents the results of the process of discrimination.

TABLE No. 1—DIFFERENCES OF INSECTS.

	ORTHOPTERA	LEPIDOPTERA	HYMENOPTERA	COLEOPTERA	HEMIPTERA	DIPTERA	NEUROPTERA
	Grasshopper	Butterfly	Bumblebee	Beetle	Squashbug	Housefly	Dragonfly
Wings	Straight	Scaly	Membrane	Sheath	Half	Two	Nerve
Mouth parts	Biting	Sucking	Biting and lapping	Biting	Sucking & piercing	Sucking	Biting
Metamorphosis	Direct	Indirect	Indirect	Indirect	Direct	Indirect	Direct
Larva	Nymph	Caterpillar	Grub	Grub	Nymph	Maggot	Nymph
Pupa	Active	Inactive	Inactive	Inactive	Active	Inactive	Active

Discrimination.—By discrimination, we mean the perception of differences. It is an important process in thinking, and every great discovery that has ever been made has arisen from the recognition of finer and finer points of distinction. A good example of this is found in Lord Rayleigh's discovery of Argon.

Discovery of Argon.—Lord Rayleigh undertook to discover the exact weight of a given volume of nitrogen. He first obtained nitrogen by extracting from the air all the oxygen, water vapor, dust, carbon dioxide and everything else that the air contained except the nitrogen, and he ascertained the exact weight of a given volume of nitrogen so prepared. Then he obtained some nitrogen by liberating it from its chemical compounds, and ascertained the exact weight of a given volume of nitrogen so obtained. The nitrogen obtained from the air weighed a very little more than that which was obtained from the chemical compounds. Repeating the processes merely showed that there was a constant difference, existing always in the same direction.

The difference was not very great. Other chemists had weighed nitrogen, and had observed that nitrogen obtained from the air did not weigh exactly the same as did that which was obtained from chemical compounds; but other chemists had regarded the differences as non-significant. They had accounted for it by supposing that they had made an error in the weighing; or that their apparatus was slightly inaccurate; or that the amount was less than the limits of possible error. But Lord Rayleigh undertook to account for this minute difference, and as a result of the finer discrimination that he employed he discovered the presence of another element, which he called argon, and which constitutes about one per cent of the air.

Effect of Discovery.—But his discoveries did not stop here. It led to the discovery of neon, krypton, xenon, other substances of the same group in the air, and the discovery of these substances made necessary a new column in the table of chemical elements. It seems now very possible that ether itself may ultimately be placed at the head of this column, the zero group of elements, and that we shall thus be furnished with a new and different explanation of some of the most important phenomena of the universe, if not a new hypothesis of the constitution of the universe itself. Such are the far reaching effects of making finer and finer discriminations.

Table of Resemblances.—Another process must now be examined. While we have been studying these different animals and observing how they differ from each other, we have also been observing how they resemble each other. We see that they all have three body divisions, segmented abdomen, seventeen body segments, six legs, two pairs of wings, jointed appendages, breathe by spiracles, all lay eggs, three thoracic segments, jaws move sideways, one pair of antennæ, compound eyes, chitinous exoskeleton, double nerve cord and ganglia. We might also observe that they are composed of many cells, are bilaterally symmetrical, take solid food, exchange carbon dioxide for oxygen, sexes different, and many other things. However, table 2 will exhibit a sufficient number of resem-

TABLE No. 2—RESEMBLANCES OF INSECTS

Housefly Beetle Squashbug Butterfly Grasshopper Bumblebee Dragonfly	Chitinous exoskeleton Three body divisions Seventeen body segments Segmented abdomen Jointed appendages One pair of antennæ Two pairs of maxillæ Three pairs of legs Jaws move sideways Compound eyes Breathe by spiracles Double nerve cord and ganglia

blances which we have observed to illustrate the process. All the animals that we have studied manifest these characteristics. They are alike in so many respects that we may group their likenesses together and designate their sum by a single word, insect. The use of the word insect is a labor saving device. No very elaborate thinking could be carried on if we were compelled to state every time one by one the entire list of characters in the table that the word insect connotes. The word insect, then, expresses the entire sum of characters which is represented by the table, or the general abstract notion. It is abstract because it expresses the characters which have been abstracted from the different individuals which we have studied. It is general, because these characters are all of them found in every individual which we have studied.

Content of the General Abstract Notion.—The general abstract notion is always derived from a table of resemblances. In the case described, the table has been written out and the notion has been obtained in a formal and conscious way, but in nearly all cases in which we form a general abstract notion, the discrimination and comparison, and making of the table has been done in an unconscious and informal manner. It is generally not at all the conscious process that we have described. We ordinarily obtain our notion by reading a word in many different connections, and the similarity of meaning in the different places in which we have used it or seen it used, constitutes for us the unconscious table of resemblances. We are generally quite unable to state distinctly the different characters that constitute the table and which make up for us the general abstract notion. But the process of comparison, is just as real, and the table of resemblances is just as truly made as if it had been written out in a formal way.

Different Contents.—From this conception of the general abstract notion and the process of its formation, some very evident and important corollaries are derived. In the first place, no two persons are likely to have exactly the same general abstract notion which a given word expresses. Some persons may have a long table of resemblances, and others have a short table; but both tables will be expressed by the same word, and it will inevitably mean somewhat different things to different persons. Since it is generally true that children get hold of words before they do the meanings, teachers find it a large part of their difficulty to fill up the empty words of children with a content. Inadequate tables of resemblances, which common nouns express, are the source of many of the ludicrous mistakes that children make when writing examination papers. They are ludicrous and funny only to persons who have a fuller content of the words.

No General Abstract Object.—Another corollary is that the general abstract notion has no actual tangible representative. It is merely a collection of characters, and the word which expresses that table of characters will apply to any individual that manifests those characters. But any individual which manifests those characters will also manifest other characters which make it an individual and which will discriminate it from other individuals.

Abstract Notion Not An Image.—The fact that certain persons habitually think in visual images has led many psychologists to consider the general abstract notion, or concept, as an image. The word concept is in a large measure responsible for this error, and is often regarded as an image. But auditory minded persons do not have a visual image, and those persons who have most occasion

to deal in a scientific manner with general abstract notions, are most completely lacking in them. The botanist or zoologist who classifies his individual objects, does it often, without ever having seen or heard of a specimen of the class to which he assigns his individual. His notion of the family or genus is altogether a printed or written description, which states merely the sum of characters, and from this he classifies his individual. Just as the person who has a complex number form is unable to understand how one who has no number form can possibly handle numbers, so the visual minded person is unable to understand how a concept or general abstract notion can be anything but a visual image. The sum of the common characters is the general abstract notion, while the sum of the common characters plus the individual characters is the singular concrete notion. Hence there are no general abstract objects, but only singular concrete objects.

Not Derived From a Single Thing.—Another corollary follows. We can never obtain a general abstract notion from a single thing. When there was only one war vessel called the Monitor, our notion of monitor was a single concrete notion. But when other vessels of the same type were constructed, then our notion of monitor became a general abstract.

Comparison.—The process of perceiving resemblances is called comparison. It is of equal importance with the process of discrimination. The two processes may exist in different degrees in the same person, although both are of importance. The person who perceives resemblances is the person who is able to become a philosopher, and to discover the element of identity in diverse phenomena.

The Only Process of Learning.—The two processes of discrimination and comparison lie at the foundation of all processes of learning. There is no way of learning anything except by discovering how it is like or how it differs from something else. This is merely another way of saying that all knowledge is relative, and that nothing exists out of relation. Knowledge begins when we observe differences and resemblances.

Resimilation.—As we were able to reduce all laws of association, even the law of contrast, to the law of resemblance, and so define all relation as resemblance, so it is possible to show that the processes of discrimination and comparison are merely different aspects of the same process. It is impossible to perceive difference without at the same time discovering resemblance. We may call this one process the perception of resemblance, but in order to avoid the use of the word perception in the expression perception of resemblance, as well as to avoid adopting one of the two processes which we have described to the exclusion of the other, we may better coin a new word. Let us use the word resimilation, to mean perception of resemblance.

Physiological Interpretation of Resimilation.—It is difficult to understand how discrimination and comparison may be reduced to the same process, unless we image it in physiological terms. Let the circle which represents the brain center A have seven tenths of its cells common with brain center B. The element of resemblance will be represented by the common section x, and the element of difference by the other portions of the two circles. When a nervous impulse passes through the circle A and from there into the circle B, the transmission of the impulse through the common section will be the concomitant

of the perception of resemblance, and there will be feeling of similarity. But in the transmission of the impulse through the two brain centers, the impulse will pass through the portions of the two centers that are not common and the concomitant feeling will be a feeling of difference. Hence the physiological concomitant of the process of discrimination is the transmission of the impulse through the non-common cells, and the physiological concomitant of the process of comparison will be the transmission through the common cells. Since in the process of transmission through both centers both the common and the non-common cells are traversed, we shall see that both processes have their concomitants in the single process of the transmission of the impulse through the entire group of cells. The transmission is a single physiological process, and the process of re-similation is its single psychological concomitant.

DEFINITIONS

General Abstract Notion.—A general abstract notion is the sum of all the characters that are common to a series of objects.

Common Noun.—The expression of a general abstract notion.

Singular Concrete Notion.—A percept; or the sum of all the sensations that we obtain from an object. Each sensation in us corresponds to a quality in the object.

Proper Noun.—The expression of a singular concrete notion.

Abstraction.—The process of examining or attending to a single part or property of an object to the exclusion of the other parts.

Analysis.—The process of examining a part or quality of an object in its relations to other parts or qualities.

Discrimination.—The process of perceiving differences.

Comparison.—The process of perceiving resemblances.

Generalization.—The entire process involved in forming a general abstract notion. It includes abstraction, analysis, discrimination, comparison. The process results not merely in the formation of a general abstract notion, but also in the discovery of a law, or the statement of a principle.

Resimilation.—The perception of resemblance. The word resemblance is here used to include also difference, as indicated before. The entire process of discovering likeness and difference.

CHAPTER III

PROPERTIES OF THE GENERAL ABSTRACT NOTION

Origin of the Notion.—The general abstract notion is the sum of all the resemblances which we have discovered in the objects studied. The common noun which expresses it has its meaning for us in that table of resemblances. When we have said insect, we have said everything that is included in table 2. In only a very few cases is such a table consciously prepared, but every common noun is obtained from a table that is just as real as if it were consciously written out. Every general abstract notion is derived from such a table.

Logical Definition.—This, however, does not enable us to make a definition. We may say that a beetle is an insect—, but if we stop here we have not made a definition. We have said a great deal; we have said everything that is included in the table of resemblances, but we have not defined beetle. A grasshopper is an insect, and so is a bumblebee, from which we have not discriminated beetle. We may make such a discrimination by inserting in our definition the characters in the table of differences in the column under beetle. Then we shall have a definition of the following form: A beetle is an insect that has sheath wings, biting mouthparts, and indirect metamorphosis.

Parts of the Definition.—It will be seen that this definition contains two parts; first the name of the comprehensive group, which is derived from the table of resemblances, and second, the differences that distinguish the thing we are defining from other members

of the same group. The first is a general abstract notion derived from a table of resemblances, and is called the *genus.* The second element of the difinition consists of the characters found in the table of differences, and are called the *differentia.* No definition can be satisfactory that does not include both of these elements. Such a definition is called a logical definition, and it expresses the nature of the thing defined. Most of our dictionary definitions are not logical definitions, but statements of descriptive characteristics by means of which we may be able to identify the thing described. When I say that Mr. Laird's house is 318 Forest Avenue, I have not made a definition of Mr. Laird's house, but merely stated one characteristic by means of which it may be identified.

Notion of Arthropod.—We have now arrived at a general abstract notion of insect and by a similar process we may reach a general abstract notion of arthropod. If we study a spider, centipede and crawfish we shall see that they have characters in common with the grasshopper, but that the number is not so large as that which exists between the insects previously studied. Let us examine tables 3 and 4.

TABLE No. 3.—DIFFERENCES OF ARTHROPODS.

	INSECTA Grasshopper	ARACHNIDA Spider	MYRIAPODA Centipede	CRUSTACEA Crawfish
Body divisions	Three	Two	One (differentiated)	Two
Skeleton	Chitinous	Chitinous	Chitinous	Calcareous
Antennæ	One pair	None	One pair	Two pairs
Eyes	Compound	Simple	None	Compound
Breathing	Spiracles	Air gills	Spiracles	Gills
Number of legs	Three pairs	Four pairs	31 pairs	Ten

TABLE No. 4—RESEMBLANCES OF ARTHROPODS

Grasshopper Spider Centipede Crawfish	Exoskeleton Jointed appendages White blood Jaws move sideways Double nerve cord and ganglia Specialized breathing organs

From table 4 we are able to arrive at a general abstract notion of arthropod, and from table 3 we are able to make a logical definition of insect. We may define an insect as an Arthropod which has a chitinous exoskeleton, two pairs of wings, one pair of antennae, seventeen body segments, compound eyes, three body divisions, breathes by spiracles.

Different Ranks.—It will be seen from this that the notion arthropod is not of the same rank as is the notion insect. Arthropod includes all the individuals that are included in the notion insect, but there are many arthropods that are not insects. Some arthropods are spiders and others are centipedes. General abstract notions are of different ranks.

Scientific Notions.—Zoologists and botanists, whose subjects better illustrate the process of making a general abstract notion than any others, and who have been compelled to study the process by which it is made, have devised a convenient method of expressing this fact. The general plan is as follows: Individuals that are alike, as nearly alike as parent and offspring, make up a species. Species that are alike make up a genus. Genera that are alike constitute a family. Families that are alike make an order. Orders that are alike constitute a class. Classes that are alike make up a branch, and branches that are alike make up a kingdom. Individual, species, genus, family, order, class, branch, kingdom are the names of different ranks of general abstract notions that

botanists and zoologists have adopted. There are many subdivisions and other ranks, but these eight rankings are universally recognized. In some books on zoology there are employed as many as twenty one different rankings of general abstract notions.

Rank Depends Upon Degree of Resemblance.—We have said that notions that are alike, which contain the same characters, constitute the notion of the next higher rank. It will be seen at once that the essential process in making each notion is the perception of resemblance, and that the degree of resemblance, as represented by the number of characters, varies with the notions of different ranks.

Genus.—We have used the term genus, in our description of the process of making a logical definition. It will be seen that the word means something different from what it does when we speak of genus as one of the distinctions of rank of general abstract notions. As we use the term in making a logical definition, it means any comprehensive group that is composed of groups or notions of a lower rank. When we speak of genus as one of the ranks of general abstract notions, we mean a rank of a particular degree of complexity. In making a logical definition, we must use as our genus the name of a comprehensive group that shall include the one we are defining. Since there may be several groups of different ranks that will include the one we are defining, it is necessary to know which group we ought to employ. Thus in making our definition of insect we may use for our genus either arthropod or animal, since both of them are general abstract notions that include insect; but we should always use the notion of the next higher degree of complexity, or as logicians express it, the proximum genus.

Coordinate Ranks.—Of course it will be understood that kingdom, class, order and so on are names of ranks, not names of notions. There may be several notions, coordinate with each other and all having the same rank. Thus in the rank of kingdom, there are three general abstract notions, the animal, mineral and vegetable kingdoms. So zoologists describe eight different branches of the animal kingdom, all coordinate with each other, but each notion designated by a different name and composed of a different group of characteristics.

Comparison of Tables.—If we examine tables three and four, we shall see that table four is a shorter table than is table two. Also we shall see that all the characters found in table four exist in table 2, and that the characters in table 2 which are not found in table 4 are found in table 3. Table 2 has been split up into a table of differences and a table of resemblances.

Comprehension.—As our notion of higher rank is formed, the table of resemblances becomes shorter and shorter, and the number of resemblances among the individuals that have been examined become fewer. This fact is expressed by saying that the comprehension of the notion is less. Comprehension is that property of the notion which refers to the number of characters that make it up. The greater the number of characters, the greater the comprehension. The table of resemblances which constitutes the notion of insect is longer than that which constitutes the notion arthropod, and the notion *insect* is said to have greater comprehension than the notion *arthropod.*

Extension.—But at the same time that the table of characters has been growing shorter, the number of individuals that manifest those characters has become

greater. There are more arthropods than there are insects. This property of the notion is expressed by saying that the extension of the notion has been increased. Extension is that property of the notion that refers to the number of individuals which manifest the characters constituting the notion. In general we may say that extension and comprehension are reciprocally related to each other. The greater the extension the less the comprehension, and the less the extension the greater the comprehension.

Summum Genus.—We cannot define beetle until we have a notion of insect. We cannot define arthropod until we have a notion of animal, and we cannot define animal until we have a notion that is extensive enough to include animal and plant. We must always have a notion of sufficiently high rank to include as a species the notion that we are defining. So in order to define animal we must have a notion, such as organic being, that would include animals and plants. In order to define organic being we must have a notion that will include organic being and inorganic being. This notion may be called simply being. But we cannot define being until we shall have a notion sufficiently extensive to include both being and not-being, and what we may call this notion no one can say. The summum genus, in the words of the old logicians, cannot be defined. But it is upon this conception, that being and not being are identical, that Hegel, the great philosopher, founded his whole system.

Other Abstract Notions.—We have been using illustrations that lead to the formation of the general abstract notion expressed by a common noun; but it must be evident that it is the same process that leads us to the meaning of any notion, no matter what part of speech

expresses it. The notion expressed by a verb is as truly a general abstract notion as is that expressed by a common noun, and so is the notion expressed by an adjective or a preposition. Nearly all of our common words are of this kind. The only real things are the particular individuals that we perceive. We may define some of our most difficult words as expressions of general abstract notions. Thus life may be defined as the general abstract notion which is composed of the characters that are common to all living things. Mind is the general abstract notion composed of all the characters that are common to all mental processes. Character is the general abstract notion consisting of all the qualities common to the actions of a person. These are helpful and necessary processes of thinking, but we lead ourselves into error if we consider them as real existing entities and make of them causes.

Generalization.—So far we have been discussing the formation of the general abstract notion, and have described the process in detail. The entire process may be called generalization, and leads not merely to the formation of a general abstract notion, but when applied to other processes, it may result in the formation of a law or the statement of a principle. The essential element in the process is resimilation, which is illustrated in our physiological figure by supposing that the same cells are traversed in the course of the transmission of a nervous impulse through two different brain centers.

DEFINITIONS

Logical Definition.—A logical definition is a statement that manifests the nature of the thing defined. It always includes two elements, the genus and the differentia.

Genus.—Genus is the name of the comprehensive group to which the thing we are defining belongs. It is always a general abstract notion.

Differentia.—Differentia are the differences or characters which separate the thing we are defining from other members of the same group.

Extension.—Extension is that property of the general abstract notion that refers to the number of individuals included under the notion, or to the number of individuals that manifest the characters that constitute the notion.

Comprehension.—Comprehension is that property of the general abstract notion that refers to the number of characters that constitute the notion.

CHAPTER IV

JUDGMENT

The association of ideas in the case of judgment is almost without exception an intimate association of simultaneous ideas, and an association in which conceptions of relation are of special importance. Of all possible associations, a judgment is just that select association in which no contradictory ideas occur.—*Ziehen, Physiological Psychology, p. 228.*

Every proposition expresses resemblance or difference of the things denoted by its terms.—*Jevons, Principles of Science, p. 24.*

A similar interpretation of the relation leads Binet to assert that all perception is judgmont. Both of these terms serve merely to point out the similarities of the perception process to the more complicated mental processes, and in so far we may accept them.—*Pillsbury, Attention, p. 118.*

Judgment is the mental assertion of the degree of relationship arrived at in some one stage of the process of conception.—*Baldwin, Handbook, Vol. I, p. 283.*

Meaning of Judgment.—The word judgment is used with a greater variety of incompatible meanings than is any other word in psychology. It is employed to mean discrimination, belief, perception, analysis, distribution of sensational elements, the fundamental element in eyery intellectual process, and perhaps several other meanings. At the same time, different users of the word seem to believe that they are talking about the same thing, each claiming that his use of the word is the true meaning. Hence it is impossible to use the word at all without a careful definition of what is meant by it.

By judgment, in this book, we shall mean the movement of thought involved in perceiving the resemblance between two notions. This is the common meaning employed by writers on logic, and it is both logical and

psychological. That there is a possibility of comparing two notions will be denied by no one, and that a psychological process is employed in making the comparison is equally evident. It is that psychological process which is employed here as the content of the word judgment.

Process of Judging.—In judging we hold in mind two notions and decide that they agree or disagree. Thus we may hold in mind the notion of snow and the notion of whiteness and we decide that they agree. We hold in mind the notion of insect and the notion of vertebrate, and we decide that an insect is not a vertebrate. In every case we decide upon the agreement or disagreement; we discover a resemblance or a difference. We express the judgment by is or is not. Such a judgment is called a qualitative judgment, and there are two varieties. The judgment of agreement is called the affirmative, and the judgment of disagreement is called the negative judgment.

Two Kinds of Judgment.—In our study of the laws of association we learned that it was possible to reduce the law of contrast to the law of resemblance and that we might use the term resemblance in a sense broad enough to include the element of difference. Similarly it is possible to discover that every judgment consists in the perception of resemblance between two notions. However, it will be convenient for us to retain the distinction between negative and affirmative judgments.

Judgment A Resimilation.—We have learned that in a percept we perceive the resemblance between the qualities of an object, and that the percept is really the sum of sensations associated by the law of coexistence and contiguity. In forming a general abstract notion, we perceive the resemblance between two or more singular concrete notions. In making a judgment we perceive the resem-

blance between two general abstract notions, although it is not necessary that the notions shall both of them be abstract. The similarity between perception, forming a general abstract notion, and judgment, is that in all of them there is the same process of the perception of resemblance. The difference exists in the things between which the resemblance is perceived.

Physiological Interpretation of Judgment.—The same figure may be employed to express the physiological process of the perception of resemblance that we have already described in the process of forming the general abstract notion. Two circles having a common section x may represent the two combinations of cells that are traversed by impulses when we experience the two general abstract notions whose resemblance is perceived. The nervous impulse passes directly from one brain center to the other by means of the common section when we make a judgment of agreement. Even if the judgment be one of disagreement, we shall find that the same figure will illustrate it.

Propositions.—The expression of a judgment is a proposition. Every proposition contains three elements which correspond to the three elements in a judgment. The three elements of the proposition are the subject, predicate and the copula. In every judgment we shall find that there are two notions and the judgment itself. The two notions, however, are not of the same rank in the judgment, and perform different functions. One of the notions is a standard of comparison, and the other notion is brought up beside it to be compared with the standard. The expression of the notion that is the standard of comparison is the predicate of the proposition and the expression of the notion that is compared to the standard is the subject. The copula is the expression of the judgment itself.

Varieties of Judgment.—In general it is true that the extension of the notion which is expressed by the predicate is greater than the extension of the subject notion. But the comprehension of the subject is greater than the comprehension of the predicate. Since we have defined the notion as the sum of characters, it appears that it is necessary for us to indicate the difference between the two notions by making the circle which will represent the cells traversed by an impulse when we experience the subject notion larger than that which expresses the predicate notion. Also, it will seem that in many cases of a judgment of agreement it will be necessary to include the predicate notion wholly within the circle represented by the subject notion. If the agreement is complete, as may be expressed by such propositions as six is six; or once one is one; or pigs is pigs, then we may express the fact by making the two circles coincide. Such judgments are called identities. Nearly all judgments, however, are perceptions of agreement in merely certain respects, or partial identities. A judgment of disagreement is one in which the particular element in the notion that is compared is not found in the other. It must be represented by two circles, each indicating a combination of brain cells, some of which are common to the two centers, but the particular cells that correspond to the element in the one that is compared with the other does not belong to the common section. If the two combinations were entirely different, the process would not be an act of judgment but one of reasoning.

Another Interpretation of Judgment.—There is another opinion concerning the nature of judgment which is so well known that it must be described in this place. That opinion is that judgment is not a process of comparing separate notions, but is setting apart and separating from

each other the elements that enter into a single notion. The notion as it is first obtained consists of an undifferentiated whole. The process of judging consists in separating this undifferentiated whole into its elements and recognizing them as separate parts.

A Criticism.—This idea is a very old one. It was that adopted by Crousaz as far back as 1724, and although it has the approval of some of our best psychologists, it cannot be made to conform to the process by which a notion is built up in the mind of a child. The percept of an apple that a child gets is obtained part at a time. In case of a little child the senses do not all become functional at once, and when two or more sensations are experienced at the same time, no perception occurs until these sensations are associated by the law of resemblance. So when we see an object of complex combination, not all the sensations will be experienced the first time that correspond to the different qualities. A peripherally initiated impulse that is established by one part of the object will not be transmitted through its appropriate brain center, unless the impulse becomes very strong, or unless the same center has been traversed before. Hence it is that although we may look at a complex object, such as a landscape, we fail to experience all the sensations that we shall ultimately obtain. The process of obtaining a more adequate perception of the complex object is not a process of analysis and separation, but a process of accretion and association.

Judgment As The Fundamental Process.—The term judgment is also employed to designate the fundamental process that is common to all intellectual operations, and the attempt is made to identify it with the process previously described. It is the purpose of this book to show

that all intellectual processes have a common element, and that different intellectual processes differ principally from each other in degree of complexity. The writer believes that the fundamental process can best be described by calling it resimilation, or the perception of resemblance, and that to call it judgment is a very unfortunate designation.

Four Kinds of Propositions.—The distinction between positive and negative judgments is called a qualitative difference. But we may have judgments that apply to all the particulars, or universal judgments, and those that apply to only some, or particular judgments. This is a distinction in quantity. Each kind of judgment, and consequently each proposition, may be distinguished according to both its quality and quantity. Hence we can discover that there are four kinds of propositions; universal affirmative, universal negative, particular affirmative, particular negative. These kinds of propositions may be illustrated as follows:

Universal affirmative—All grasshoppers have six legs.

Universal negative—No grasshopper has six legs.

Particular affirmative—Some grasshoppers have six legs.

Particular negative—Some grasshoppers do not have six legs.

Although in the proposition, all insects have six legs, legs is not the grammatical predicate, but the object of have, it is the psychological predicate, and the word *have* expresses the agreement of the two notions even better than the copula *is*. To say that an insect has six legs implies that the character of six leggedness is one of the group of characters in the table of resemblances which constitutes the general abstract notion of insect.

Symbolic Propositions.—The four kinds of propositions are expressed in a shorthand manner by the letters A E I O. A expresses the universal affirmative, E is the universal negative, I is the particular affirmative, and O is the particular negative.

Diagram of Relations.—There is an old diagram which is employed to express the relations that these propositions bear to each other. The diagram is a square with two diagonals. At the upper left hand corner of the square, is placed the letter A. At the upper right hand corner, E; at the lower left hand corner I, and at the lower right hand corner the letter O.

If we examine the four propositions that we have employed to illustrate the different kinds of judgments, we shall see that certain relation exist which are necessary and inevitable. Thus if A (all grasshoppers have six legs) is true, E (no grasshopper has six legs) cannot be true. If A is not true, E may or may not be true, and we do not know which it is. It is unknown. If E is true, A cannot be true, but if E is untrue, A may or may not be true, and

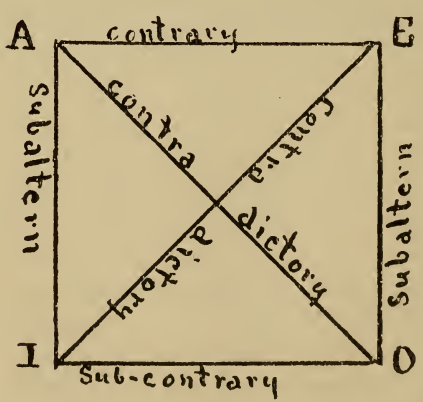


Diagram of relations between symbolic propositions.

we can tell nothing about it. E and A cannot both be true at the same time, but both of them may be untrue. This relation is called the relation of contrary.

Relations of Propositions.—Similarly, if I is true, (some grasshoppers have six legs) O, (some grasshoppers do not have six legs) may or may not be true. We cannot tell which it is, for we know nothing about O from the fact that I is true. If I is untrue, we know that O must be true. If O is true, we know nothing about it; it may or may not be true. If O is untrue, I must be true. Both of them cannot be untrue at the same time. This differs from the relation between E and A, and is called the relation of sub-contrary.

If A is true, I must be true; if A is untrue, I may or may not be true, and we cannot tell which it is. If I is true, we know nothing about A, but if I is untrue, A must necessarily be untrue also. This relation is called the relation of subaltern, and the same relation exists between E and O.

Contradictories.—The most important relation is that which exists between A and O. If A is true (all grasshoppers have six legs), then O (some grasshoppers do not have six legs) is necessarily untrue. If A is untrue, then O must of necessity be true. If O is true, A cannot be true, and if O is untrue, then A must be true. Both cannot be true or untrue at the same time. If either one of them is true, the other must be untrue, and if either one is untrue, the other must be true. The relation is called contradictory, and of two contradictory propositions one must be true and the other must be untrue. It is this rule that is employed in geometry in making an indirect demonstration. The theorem that "If two planes are perpendicular to the same straight line they are parallel, is proved

by assuming that they are not parallel, and showing that this supposition is not true. Then the contradictory proposition must be true, and the planes must be parallel.

DEFINITIONS

Judgment.—Judgment is the perception of agreement or disagreement between two notions.

Affirmative Judgment.—Affirmative judgment is the perception of agreement between two notions.

Negative Judgment.—Negative judgment is the perception of the disagreement between two notions.

Proposition.—A proposition is the expression of a judgment.

Predicate.—The predicate is the expression of the notion that is used as the standard of comparison.

Subject.—The subject is the expression of the notion that is compared with the predicate notion.

Copula.—The copula is the expression of the judgment itself.

Universal Judgment.—A universal judgment is a judgment of agreement or disagreement throughout the entire extension of the notions compared. It is indicated by *all* or *no.*

Particular Judgment.—A particular judgment is a judgment of agreement or disagreement throughout only part of the extension of the notions compared. It is indicated by the word *some,* or its equivalent.

CHAPTER V

THE SYLLOGISM

I call in question any method of reasoning which can be carried on without a knowledge of deductive processes.—*Jevons, Principles of Science, p. 12.*

Every conclusion (syllogistic) like every judgment, is merely an association of ideas. But as a distinct form of association it is almost of no importance psychologically.—*Zieben, Physiological Psychology, p. 229.*

Reasoning is a classification of relations. But what does classification mean? It means the grouping together of those that are alike.—*Spencer, Psychology, Volume II, p. 115.*

The Syllogism.—We purpose to begin our study of reasoning with the syllogism, because it is the simplest and the best understood process. The laws of the syllogism were developed by Aristotle, who died 322 B. C., and there has been little improvement made in them since his time. Even if we can show that there are other forms of reasoning, or that syllogistic reasoning is capable of being reduced to other forms, it is still true that we must know what a syllogism is, and the kind of study that has been put upon it.

Definition and Example.—A syllogism consists of a series of three propositions, two of which are so related to each other that the third one can be derived from them.

The classical syllogism employed by Aristotle and repeated by every writer on logic since his time is as follows:

All men are mortal.
Socrates is a man.
Socrates is mortal.

Instead of using this form in which one of the notions is a singular concrete notion, I should prefer to employ our old friend the grasshopper as the subject of the propositions, and use two general abstract notions. Let us examine the following syllogism.

All insects have six legs.
The grasshopper is an insect.
The grasshopper has six legs.

Parts of a Syllogism.—In this series the third proposition is called the conclusion, because it is derived from the other two. The other two are called the premises, the first of which is the major premise and the second is the minor. It will be seen that the two premises contain two general abstract notions each, but an examination of the notions involved will show that there is one notion, *insect,* that is found in both of the premises. Instead of being four notions, there are only three. The notion that is found in both premises, expressed by the term insect, is called the middle term, and is designated by the capital letter M.

Meaning of the Terms.—The major premise contains the middle term, and another which is called the major term. The major term is designated by the letter P, because it is used as the predicate of the conclusion. The minor premise contains besides the middle term another which is called the minor. It is designated by the letter S, because it is used as the subject of the conclusion. The major premise is called the major premise because it contains the major term, and the minor premise is called minor because it contains the minor term. The major term is called major because, like the predicate of any other proposition, it has greater extension than the minor term.

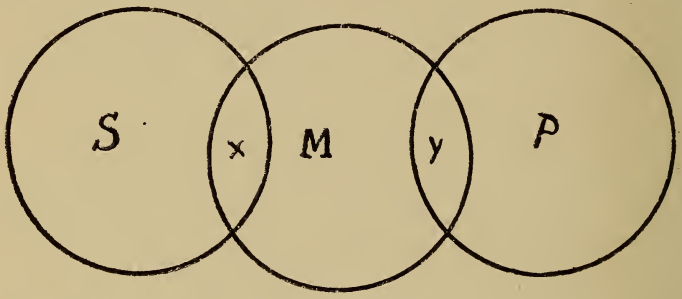
Syllogism A Process of Comparison.—In perception, we perceive resemblances between the qualities of an object. In forming a general abstract notion we perceive resemblances between singular concrete notions. In making a judgment we perceive resemblances between general abstract notions, although it is not necessary that both notions shall be abstract. In a syllogism, we have a more complex process, and it appears that we ought to say that we compare judgments, although in fact such is not the case. We compare notions in a syllogism just as we do in making a judgment, with this difference, however, that in a judgment, we compare two notions directly with each other, while in a syllogism we compare two notions indirectly by means of a third which is expressed by the middle term. We perceive resemblance between two notions in both judgment and in a syllogism, but in one case we perceive it by a process of direct comparison, while in the other, we perceive it by a process of indirect comparison.

Axiom.—There is an axiom in mathematics which with a slight change of meaning will apply here. Things that are equal to the same thing are equal to each other. So we may say that notions that are similar to the same notion are similar to each other. The paraphrase is not strictly true, for the similarity to the same notion may exist in different qualities in notions that are compared with it.

Physiological Interpretation of a Syllogism.—We may picture the physiological process that accompanies the syllogism as follows:

We may represent the two notions, major and minor, by two circles that do not intersect. We do not compare the notions directly. The nervous impulse will encounter so much resistance that it will not pass readily from one

combination into the other. But if we draw a third circle, representing the middle term M so that it shall have a section common to S and M, which we may call x, and another section common to M and P, which we may call y, the nervous impulse may pass from S into M through



Physiological interpretation of the Syllogism.—Sx is M. Mx is P.

the common section x, and from M it may pass readily into P by means of the common section y. Thus by means of introducing the middle circle, representing the middle term M, we shall find an easy passage from the center S to the center P. The resistance that would be so great as to prevent the passage directly is diminished to such an extent by going through M by means of the common sections x and y that the nervous impulse passes readily from one to the other.

Simplicity of the Hypothesis.—While the process as described is altogether hypothetical, and is without doubt much simpler than that which actually occurs, it is in its simplicity comparable to the syllogism itself as a form of reasoning, and will enable us to comprehend the process by means of the physiological image. In fact, it will be found possible to describe reasoning in physiological terms as the concomitant of the process by which we find an easy passage for the impulse from one combination of cells into another that is not directly connected with it.

Fallacies.—It is very easy to derive a false conclusion from true premises. In fact, it is very difficult to employ the syllogism in a proper way. The wrong kind of reasoning by which a false conclusion is reached is called a fallacy. There are many fallacies and rules to be observed in the employment of the syllogism, and we shall merely indicate some of the most common.

Undistributed Middle.—The first fallacy is called that of the undistributed middle and is illustrated by the following syllogism:

All insects breathe by spiracles.
A centipede breathes by spiracles.
A centipede is an insect;

which is not true. The difficulty lies in the middle term, expressing the general notion of spiracle breathing. It is not used in either proposition to include everything that breathes by spiracles. In the first proposition the term spiracle breathing includes only those spiracle breathers that are insects, and in the other proposition it includes only those spiracle breathers that are centipedes. So in neither case does it include all spiracle breathers and therefore is said to be undistributed. In the major premise we compare the notion insect with one group of spiracle breathers, and in the other premise we compare the notion centipede with a different group. So, instead of comparing the two notions, insect and centipede, with the same notion, we really compare them with different notions, or different parts of the same notion. Hence in reality we have four terms instead of three. The middle term must always be distributed, and every term that is distributed in the conclusion must be distributed in one of the premises. Distributed means to be used in such a way as to include everything to which the notion belongs. In

order that a term may be distributed it must be used as the subject of a universal or the predicate of a negative.

Illicit Process.—Another fallacy is called the fallacy of the illicit process of the major, which is merely another name for the fallacy of the undistributed major term. The major term is distributed in the conclusion when it is not distributed in the premises.

All injurious insects should be killed.
A cockroach is not an injurious insect.
A cockroach should not be killed.

The conclusion is not true. The major term is "Should be killed", and it is not distributed in the major premise. There are other things that should be killed besides injurious insects. The term is used as the predicate of a universal affirmative, instead of the subject. It is distributed in the conclusion, because it is used as the predicate of a negative. Hence we get an invalid conclusion.

Particular Premises.—Look at this syllogism:

Some insects have red wings.
Some grasshoppers do not have red wings.
Some grasshoppers are not insects.

Here the difficulty is not in the undistributed middle nor the major term. The middle is distributed, since it is used as the predicate of a negative. It is true that the major is not distributed in the premise, but there is no way to avoid this when both premises are particular propositions. The rule is that from two particular propositions no conclusion can be drawn. One of the premises must be universal.

Negative Premises.—

No insect has ten legs.
No grasshopper has ten legs.
A grasshopper is not an insect.

This illustrates the rule about negative propositions, which is that from two negative premises no conclusion can be drawn. One of the premises must be an affirmative. This fallacy is well illustrated by the conundrum, "Why is an elephant like a wheelbarrow?" And the answer is, "Because neither of them can climb a tree."

Ambiguous Middle.—To the fallacy of ambiguous middle belongs the proof that a cat has ten tails. No cat has nine tails. One cat has one tail more than no cat. Therefore, one cat has ten tails. So also we shall be able to see the fallacy in the demonstration that two is equal to zero, that every aspiring beginner in algebra so confidently shows to his teacher. The square root of 1 is 1. The square root of 1 is minus 1. Minus 1 equals plus 1, since things that are equal to the same thing are equal to each other. Adding 1 to both members of the equation, shows us that two equals zero. The fallacy lies in the ambiguous middle term. The square root of 1 may be either plus 1 or minus 1.

It will be seen from the above examples that the syllogism must be applied in the right way to obtain valid conclusions even from correct premises. We have indicated only four or five kinds of fallacies, but it is easily possible to discover twenty or thirty different kinds.

Figure.—Writers on logic speak of the figure of the syllogism. By this they mean the arrangement of the diferent terms in the propositions, or it might be described as the position of the middle term in the two premises.

The middle term may be used as the subject of both premises, as the predicate of both premises, as the subject of the major and the predicate of the minor, as the predicate of the major and the subject of the minor. In the first figure the middle term is used as the subject of the major and the predicate of the minor.

First Figure.—

All insects have six legs.
A grasshopper is an insect.
A grasshopper has six legs.

This figure may be represented by the formula MP–SM–SP.

Second Figure.—In the second figure the middle term is used as the predicate in both major and minor premises.

All insects have six legs.
A centipede does not have six legs.
A centipede is not an insect.

The formula for this figure may be written PM–SM–SP.

Third Figure.—In the third figure the middle term is used as the subject of both premises.

All insects have six legs.
All insects breathe by spiracles.
Some spiracle breathers have six legs.

The formula for this figure may be written MP–MS–SP.

Some questions may be raised why in our conclusion we say *some,* making the conclusion particular, while the premises are both universal. If the conclusion were to be universal, we should distribute the minor term in the conclusion, using it as the subject of an universal, when it is not distributed in the premises, where it is used as the predicate of an affirmative. So we shall find that every figure has its own rules, which must be regarded in order to obtain a correct conclusion.

Fourth Figure.—In the fourth figure, the middle term is used as the predicate of the major and the subject of the minor premise.

All insects have six legs.
A six-legged animal is not a spider.
A spider is not an insect.

The formula may be written PM-MS-SP.

Mood.—Writers on logic also distinguish another property of the syllogism which they call mood. By mood they mean the different kinds of propositions that enter into the syllogism. There are four kinds of propositions, and only three are necessary to make up a syllogism. So it would appear at first sight that there are 64 possible moods. Sixty-four different arrangements of four letters, A E I O, may be made using three at a time. There may be sixteen beginning with A, sixteen beginning with E and sixteen each with I and O. But an examination will show that many of these combinations must be rejected. All those combinations that have E and O as the first two must be rejected, because E and O represent negative premises. So all combinations that have for the first two letters O and I must be rejected, because they represent syllogisms in which both premises are particular. All combinations in which one of the letters represent a negative premise while the conclusion is affirmative must be rejected, as well as all of those in which one of the premises is particular and the conclusion is universal. We shall thus find that there are only ten legitimate moods, which may be expressed by the combinations AAA, EAE, AII, EIO, AEE, AOO, AAI, IAI, EAO, OAO.

Mnemonic Lines.—There is a series of barbarous mnemonic lines that are intended to indicate the moods that are legitimate in each figure. The lines are packed with information most of which it is unnecessary to learn, and it is wholly unnecessary to commit them to memory. The original lines are in Latin, but the only part which it

is necessary for us to understand is the series of words which represent the moods. The moods are indicated by the vowels in the words, while the consonants indicate certain operations that may be performed upon the syllogisms. The legitimate moods are represented by the words

First figure—Barbara, celarent, darii, ferio.

Second figure—Cesare, camestres, festino, baroko.

Third figure—Darapti, disamis, datisi, felapton, bokardo, ferison.

Fourth figure—Bramantip, dimaris, camenes, fesapo, fresison.

Although in these lines there are nineteen different words indicating nineteen moods, there are so many duplications that only ten different combinations of vowels are found. The different moods are recognized by the words in the lines. Thus the mood that contains three universal affirmative propositions is always known as the mood barbara. So when we wish to indicate the mood in the fourth figure that has both of its premises universal affirmative and its conclusion a particular affirmative, we always speak of the mood bramantip.

This discussion will show something of the nature of the study that has been put upon the syllogism. The importance of the syllogism as a method of reasoning is not very great; but it furnishes us an easy introduction into the reasoning process, and the real nature of the psychological movement upon which reasoning depends.

DEFINITIONS

Syllogism.—A syllogism is a series of three propositions, two of which are so related to each other that the third may be derived from them.

Conclusion.—The third proposition in the syllogism.

Premises.—The two propositions other than the conclusion.

Middle Term.—The middle term is the one that occurs in both premises.

Major Term.—The major term is the predicate of the conclusion.

Minor Term.—The subject of the conclusion.

Major Premise.—The premise that contains the major term.

Minor Premise.—The premise that contains the minor term.

Fallacy.—An error in reasoning by which a false conclusion is drawn.

Illicit Process.—That fallacy that arises from the major term's being distributed in the conclusion when it is not distributed in the premise.

Undistributed.—Used in a manner that does not indicate the full extent of its signification.

Figure.—That property of the syllogism that designates the position of the middle term in the premises.

Mood.—That property of the syllogism that designates the kind of propositions which constitute it.

CHAPTER VI

DEDUCTIVE AND INDUCTIVE REASONING

The sense of sameness is the very keel and backbone of our thinking.—*James Psychology, Volume I, p. 459.*

Science arises from the discovery of identity amidst diversity. —In every act of inference, or scientific method we are engaged about a certain likeness, identity, sameness, similarity, resemblance, analogy, equivalence, or equality apparent between two objects.— *Jevons, Principles of Science, p. 1.*

By no inductive process can we prove the universal. But reason, assuming the uniformity of thought, universalizes the uniformity of nature.—*Lloyd Morgan, Comparative Psychology, p. 285.*

The uniformity of nature is a condition of all mental development, as of all reasoning; but it is not conceived as a condition until reason is firmly seated on her throne.—*Lloyd Morgan, Comparative Psychology, p. 285.*

This principle (of identity), is therefore the highest form of thought, the postulate on which all science depends. The relation of similarity underlying all association of ideas is expressed by the principle of identity in an ideal and absolute form which our actual associations attain at best only approximately.—*Hoffding, p. 177.*

Limitations of the Syllogism.—The syllogism has some very serious limitations, that largely diminish its usefulness. In the first place, not all forms of reasoning are capable of being reduced to the syllogistic form. I look up at the sun and say that the sun dazzles my eyes. Or I lay a lath between two tables and propose to walk across it. The reasoning process by which you arrive at the conclusion that the lath will break and precipitate me to the floor is enormously complex; too complex ever to be reduced to the form of a syllogism. Even if we were to undertake to reduce the demonstration of a simple theorem in geometry to a series of syllogisms, we should find that the process is very long and difficult to accomplish.

Fallacies.—In the second place, it is difficult to avoid fallacies in making use of syllogistic reasoning. Some kinds of fallacies are difficult to detect. In the preceding chapter we have mentioned five kinds, but it would be easy to extend the list to twenty-five. We can seldom affirm that we have avoided every possible fallacy, and must always assert the validity of our conclusion subject to the qualification "If we have avoided all fallacies."

Not Affirm Truth of the Premises.—The third limitation is that the syllogism does not affirm anything about the truth of the premises. All that it does affirm is that if the premises are true and all fallacies are avoided, then the conclusion is true. But the test of the truth of the premises must be made by some other means than by the syllogism itself.

Not Discover The Premises.—The fourth limitation is somewhat like the third. The syllogism does not enable us to obtain the general truths that are used as the premises in any train of reasoning. We must have the general truths, one of which at least must be universal, but there is no way in which they may be obtained by syllogistic reasoning. This in itself shows that the syllogism is not an all-sufficient form of reasoning.

A fifth limitation is that the syllogism does not disclose any new truth. Everything that is affirmed in the conclusion has already been stated in the premises. When I have said that all insects have six legs, I have stated the fact already about the grasshopper. The conclusion is already involved in the premises.

One Advantage.—The one advantage of the syllogism is that it discloses truth that is involved in the premises when we should not discover that it is there unless it were disclosed by such a process. The truth that the

surface of a sphere is equal to the area of four great circles is involved in the definition of a sphere, a circle, and two or three other definitions and axioms; but we should never discover the truth in these definitions and axioms if it were not for the process of reasoning.

Deductive Reasoning.—Syllogistic reasoning was regarded, from the time of Aristotle down to the time of Francis Bacon, as the only form of reasoning. It was believed that the mind always reasoned syllogistically and that if we wished to do so, all processes of reasoning could be reduced to the syllogistic form. Francis Bacon described a different form of reasoning which is called induction. The syllogism is the best example of deductive reasoning.

Inductive Reasoning.—Deductive reasoning begins with general truths and reasons to a particular conclusion. The premises with which we start are always wider than the conclusion. It is a process of reasoning from the general to the particular. Inductive reasoning starts with the particulars and reasons to the general. The premises are never so wide as is the conclusion.

If I wish to discover the general truth that all insects have six legs, I begin with particular individuals. I examine an insect and count the number of its legs. Then I examine as many more insects as I can, and perhaps induce all my friends to examine and report the number of legs that they discover on insects. Suppose that I and my friends have counted the number of legs on a hundred thousand insects, then from this I reach the conclusion that all insects have six legs.

One Limitation.—There is one limitation on inductive reasoning as it is here described, and that is that there is

no way of being certain that after having counted the number of legs on a hundred thousand insects, the very next insect examined may have not six but eight, or four, or some other number. The sun has always risen in the east, but there is no necessary connection, so far as the reasoning process can discover, that will make it impossible for it to rise in the north or west tomorrow. So inductive reasoning cannot assert absolute certainty.

Complete Induction.—There is one process by which absolute certainty may be attained, and that is by a process of complete induction, in which every particular is examined. The earth has only one moon. Everything that by any possibility might be a moon has been examined, and only one has been found. There is no student in school that is more than 150 years old. Every student has been examined in this respect. There is no building in Ypsilanti that is 13 stories high. Every building has been examined. In this way absolute certainty can be obtained.

Not Reasoning.—There are two things to be said about complete induction. One of them is that it is not a form of reasoning at all, and does not differ from direct observation. The other limitation is that there is no gain by such a reasoning process. The conclusion is no wider than the premises. So all the gain and the increase in knowledge that we can acquire in reasoning must come from incomplete induction.

Suppose that I have examined a hundred thousand insects, and have found that all of them have six legs. I reason from this to the general conclusion that all insects have six legs. The conclusion is wider than the premises.

How Reach Inductive Conclusion.—The process by which this conclusion is reached may be clearly stated in the following series of propositions:

All insects that I have examined have six legs.
All insects are like those that I have examined.
All insects have six legs.

It will be seen that this train of reasoning takes the form of a syllogism of which the major premise is a complete induction, all insects that I have examined have six legs. The minor premise is an assumption without any positive evidence of its truth, and this is the possible source of error. The conclusion is derived from these two premises.

The Premises.—In the first premise, "All insects that I have examined" is the middle term. The major term is, "Have six legs." In the minor premise the minor term is "All insects." We see that the syllogism contains three propositions, all of them universal affirmative. It is a syllogism of the first figure and of the mood barbara, and we shall find that the first figure of the syllogism is involved in every process of inductive reasoning.

Uniformity of Nature.—Every process of inductive reasoning involves this deductive process. The minor premise is obtained by assuming the uniformity of those things that we have not examined with those things that we have examined. Putting it in very general terms, we may say that every induction involves an assumption of the uniformity of nature. I believe that the sun will rise tomorrow, for my total experience has been that it has risen every morning. It has always risen in the east, and it is easy for me to believe that it will rise in the east again, although there is nothing in the nature of my reasoning process that would compel me to assent to the proposition that it might not rise in the west tomorrow. If any one

choses to assert that it will rise in the west tomorrow morning, and challenge me to prove that it would not, although I might suspect his sanity, I should be compelled to reply, "Let us wait and see."

Origin of Intuitive Ideas.—The fact that every insect that I have examined has six legs makes it easy for me to believe that every other insect, when it is examined, will be found to have six legs, and it is easy for me to make the assumption without having examined every particular. The experience of our ancestors with certain things has been just like our own, and has probably contributed to our readiness to assume the truth of the axioms of mathematics, and the things that were designated by former psychologists as intuitive ideas and necessary self-evident truths.

Superstitions.—No reasoning process is possible without this belief in the uniformity of nature, and yet our belief in such uniformity is not very strong. When we overturn the salt cellar, we throw a pinch of salt over our shoulder. This implies that we do not believe that things will go on as they did before we overturned the salt cellar. So we knock on wood, refuse to turn back when we have forgotten something, hang a snake on the fence, watch for the moon over our right shoulder. These things imply a belief in the fact that nature is not uniform, but that something may constantly interfere to change the course of natural events. It really involves the kind of fallacy that is called irrelevant conclusion. In case of these superstitions, there is not the necessary connection between our actions and the events they are supposed to influence that we assume that there is.

Insufficient Number of Particulars.—One serious error in making an induction is the failure to examine a suffi-

cient number of particulars to avoid a wrong assumption. We assume a uniformity of the things that we have not seen with the things that we have seen, when an examination of a larger number of particulars would show that they are not similar. Thus the square of three is nine and the square of four is sixteen. The sum of nine and sixteen is twenty-five, which is a perfect square. So the square of six is thirty-six and the square of eight is sixty-four. The sum of thirty-six and sixty-four is one hundred, which is a perfect square. The sums of all squares that I have examined are perfect squares; the sums of all squares are like those that I have examined; therefore the sum of any two squares will be a perfect square, which is not true. An examination of sufficient number of particulars will enable us to avoid such mistakes.

Induction and Deduction Inseparable.—The conclusion obtained by inductive reasoning is a general truth that may be used as the major premise in a syllogism or other form of deductive reasoning. Thus we see that every deduction demands a previous induction, and we have also seen that every inductive conclusion is reached by a deductive process, so that deduction and induction cannot be separated, but must always go along together. In fact, there are not two processes, but a single process. Writers on logic are now inclined to talk about the deductive-inductive process, but it appears that we may make a more nearly accurate analysis of the entire process. In deduction, we perceive the resemblance between two notions, and in induction we perceive the resemblance between the particulars from which the notion is derived. The two processes are identical in the fact that they both consist in the perception of resemblance, and this is the fact that connects reasoning with all other forms of the intellectual

process. Reasoning is merely a complex form of resimilation, as judgment and generalization are simpler forms. We already have a physiological interpretation for the process of resimilation, and so find it possible to think of reasoning in physiological terms.

DEFINITIONS

Deduction.—A process of reasoning from generals to particulars. The syllogism is the most typical form of deductive reasoning.

Induction.—A process of reasoning from particulars to generals.

Complete Induction.—A process of drawing a conclusion from an examination of every particular.

Incomplete Induction.—A process of drawing a universal conclusion from an examination of only a part of the particulars.

CHAPTER VII

OTHER FORMS OF REASONING

Knowledge is impossible without hypotheses.—*Haeckel, Wonders of Life, p. 86.*

To make hypotheses, to verify them by experiment, then to connect by the aid of generalizations the facts discovered, represents the stages necessary for the building up of all our knowledge. —*LeBon, Evolution of Matter, p. 317.*

It is only in the present century that physicists have begun to recognize this truth (i. e., that while science was supposed to be advancing by the Baconian method, hypothetical investigation was the real instrument of progress). So much opprobrium had been attached by Bacon to the use of hypotheses that we find Young speaking of them in an apologetic tone.—*Jevons, Principles of Science, p. 508.*

Among uncultivated observers, the tendency to remark the favorable and to forget the unfavorable events is so great that no reliance can be placed upon their supposed observations.—*Jevons, p. 402,*

All science starts with hypothesis.—*Huxley, Hume, p. 65.*

Since perception rests upon a process that may be described as involuntary comparison, it manifests itself as an activity of thought by means of which we appropriate what is given in the sensation, incorporate the sensation into the content of our consciousness.—*Hoffding, p. 130.*

Analogy.—In deduction we begin with the general and reason to the particular; we begin with the many and reason to the one. In induction we begin with the particular and reason to the general; we begin with the one and reason to the many. If we reduce the many that we begin with in deduction, and reduce the many that we reason to in induction, we shall ultimately approximate a condition in which we reason from one to one. Whether

this one that we begin with is the general of deduction or the particular of induction may be a question; and whether the one that we reach in the conclusion is the particular of deduction or the general of induction is also difficult to determine. By this process, however, we are able to show that deduction and induction are the same process. It is a process of reasoning from particular to particular, as described by John Stuart Mill, and which Jevons asserts is not a form of reasoning at all. It appears, however, not only to be a form of reasoning, but the most common form. It is a special form of induction which we may call analogy.

Differs From Baconian Induction.—The very name analogy implies the perception of resemblance. In reasoning by analogy we begin with a particular, and this is sufficient to indicate that reasoning by analogy is a form of induction. The difference however, is that in the typical Baconian induction, we begin with the largest number of particulars that we can get. In analogy, we do not try to secure the largest number of particulars, but, in the most common examples, we begin merely with one, and reason to the many, or the universal.

Analogy is a valid form of reasoning and is the most common form of the reasoning process that we employ. It leads to valid conclusions if we observe the proper precautions. It is by this process that the larger number of our daily actions are determined. When I find the thermometer at my house flirting with the zero mark, I do not need to make an examination of as many thermometers as possible in order to come to the conclusion that I shall not find balmy zephyrs blowing around the normal school building. I do not need to observe the ice in the pond, the hardness of the ground, the other indications of frost of as many different kinds as possible,

to come to the decision that it is cold. When I start out and find one crossing is muddy, I do not need to examine all other crossings in town to induce me to go back and get my rubbers. I reason from the one particular that all other crossings are likely to be muddy. So when I find it raining at my house, I reason from this one particular that it is raining in every other place in town, and get my umbrella.

Deductive Process In Analogy.—Like every other form of induction, analogy involves a deductive process. My reasoning is as follows: This crossing is muddy. Every crossing in town is like this crossing. Every crossing is muddy. The mistake may occur in the second, minor, premise. It may be that not all other crossings in town are like this crossing, and my reasoning will lead me to a wrong conclusion.

Analogy In Geometrical Demonstration.—In geometry we employ the same process of reasoning. We have described the demonstrations in geometry as among the best examples of deductive reasoning, but there is also employed in them an inductive process which is that form that we have called analogy. When I have proved that in one triangle the three angles are equal to two right angles, I do not have to demonstrate it for as many triangles as I can draw, and as many as I can get my friends to draw. I reason from this one particular triangle to the general conclusion that the sum of the angles of all triangles is equal to two right angles. My minor premise is that All triangles are like this triangle, and if this premise is true my conclusion is a valid one.

Fallacies In Analogy.—But sometimes the analogy does not involve any necessary connection between the things observed and others that are assumed to be like it. There

was a Mohammedan doctor who always prescribed a white medicine for a chill, red medicine for fever, and yellow medicine for jaundice. Similarly the story is told of a negro physician who when called upon to treat a case of hemorrhage of the lungs prescribed a dose of mustard and a dose of mucilage. He explained this system of therapeutics by saying that he wanted the mustard to draw the parts together and the mucilage to make them stick. When the planet Uranus was discovered, there were learned men who gravely argued that there could be no such planet as Uranus. There were only seven days in the week, only seven metals, seven colors in the rainbow, seven intervals in the octave, and consequently there could be only seven planets. As there were five already known, the number with the earth and moon was complete, and no other planet was possible. The difficulty with this reasoning was that there was no necessary connection between the seven days in the week and the seven planets.

Origin of Superstitious Beliefs.—Many common beliefs rest upon the evidence of analogy observed in a single particular, and contradictory instances are neglected. If it should rain on Easter Sunday it will rain for the succeeding seven Sundays. One time in boyhood, the writer observed this occurrence, and he has had a mild form of belief that it will always happen so. Potatoes planted in the light of the moon will all go to tops. A cloud coffin seen in the sky foretells the death of some one in the family. A bell ringing in one's ears indicates the same kind of disaster. A dog howling at night indicates a death, although in case of the writer, it is more likely to be the death of the dog. Most of such beliefs have probably arisen somewhere by the observation of a single instance, and the general conclusion has been

drawn. The only way to avoid such errors in reasoning is to look for the evidence of a necessary connection, and to examine a number of particulars, as well as to be especially watchful for contrary instances.

Limitations of Analogy.—Sometimes an analogy will hold for a few instances and then break down. An equation containing one unknown quantity may be represented by a straight line. An equation containing two unknown quantities may be represented by a curve, enclosing a surface. An equation containing three unknown quantities, requires a solid to represent it. What would represent an equation containing four unknowns? But it is from a consideration of such analogies that we derive our pseudo notion of a fourth dimension of space. A moving point will generate a line; a moving line will generate a surface, a moving surface will generate a solid, but what will a moving solid generate? The analogy breaks down at this point.

Hypothesis.—Analogy is principally useful in suggesting a probable truth. By means of analogy we may make a guess at what a truth may be. We may act upon this probable truth, or if the case is an important one and does not demand immediate action, we may proceed to verify it. This leads us to the form of reasoning that is called hypothesis. Hypothetical reasoning begins with an examination of particulars, just as does any other form of induction; but in the typical Baconian induction we examine as many particulars as possible and draw our conclusion, with which the process stops. In hypothesis, we do not employ as many particulars as possible, but only a sufficient number of the most significant. A small number of particulars, as unlike as possible, will be more serviceable in framing a hypothesis than a larger number of concordant examples. When we have drawn our conclusion from the

particulars considered, we have merely formed the hypothesis, from which we proceed to reason. The termination of the induction is merely the first step by which the truth is established.

Second Step in Proof.—The hypothesis must agree with all the observed particulars. The second step is the collection and examination of new particulars. If all the new particulars which are discovered and examined fit into the hypothesis and none of them contradict it, then we have another reason for believing that it is true. The hypothesis was formed before the new particulars were examined, and the fact that they fit into it is rather strong evidence of its truth. It is somewhat like the stories of two witnesses who have not consulted with each other. If neither knows what the other has told, the evidence is stronger than if they have consulted with each other and each has heard what the other has said.

Third Step.—The third step in the verification of an hypothesis is a process of deductive reasoning. Assuming that the hypothesis is true, we may use it as a major premise and reason backward to the particulars. If the particulars that we reach by our process of deductive reasoning correspond to the particulars that we observe, then our hypothesis is assuming a high degree of probability. When Newton proposed his hypothesis of gravitation, he proceeded to test it deductively. His hypothesis was that the moon, like other bodies, falls toward the earth with a velocity proportional directly to the mass and inversely as the square of the distance. He knew, or thought he knew, the size and mass of the earth, and the distance that it was from the moon. His calculations showed that the moon ought to fall toward the earth at the rate of thirteen feet a second, when direct observation showed that it did fall

at the rate of fifteen feet a second. The discrepancy was too great, and he abandoned his hypothesis. He laid his papers away, and thirteen years afterward, learning of a new measurement of the earth, he introduced this new value into his calculations, and found that the calculated distance agreed exactly with the observed distance. This agreement testified very strongly in favor of the hypothesis, and gave it a high degree of probability.

Fourth Step, Prediction.—But there is a fourth step in the verification of an hypothesis. Assuming that the hypothesis is true, we may predict that other things are true, and search for those particulars which would not likely be found, if it were not for the hypothesis. If we can verify our predictions made from the hypothesis, we have approximated the demonstration of its truth as nearly as it is possible to demonstrate the truth of anything. There is no higher test of the truth of a general principle than this.

Newton's theory of gravitation has led to many verified predictions of this kind. After the planet Uranus was discovered, an orbit was calculated for it according to the laws of gravitation. In a few years the planet failed to move accurately in the orbit. Either the law of gravitation was not true, or there was some other cause for the variation from the orbit. Accordingly, an English mathematician, Adams, and a French astronomer, Leverrier, undertook to calculate the size, position and distance of a planet outside the orbit of Uranus that should account for its deviation. Leverrier on the very night that he finished his calculation wrote to his friend, Dr. Galle, in Berlin, telling him to point his telescope at a particular spot, and he would see a star of the eighth magnitude, which would be a new planet, never before seen. On the very evening

that he received the letter, Dr. Galle, following the directions of Leverrier, saw the planet. This discovery furnished the highest possible evidence of the truth of the theory of gravitation. Marconi's discovery of wireless telegraphy came as a prediction based upon the theory of electric waves in ether.

Examples of Hypothesis.—The theory of planetary orbits, Kepler's laws, the atomic theory of matter, the kinetic theory of gases, theory of light, luminiferous ether, evolution, or the derivative origin of species are all examples of discoveries made by hypothetical reasoning. We are sometimes told that the doctrine of evolution is merely a hypothesis, and has never been satisfactorily demonstrated. This is true, but no other theory, not even Newton's theory of gravitation, has furnished one one-hundredth as many examples of verified predictions as has the theory of evolution. Our hypothesis of the nervous current with its psychological concomitant for each element is another example of hypothetical reasoning. We cannot say that it has been demonstrated, but if we find new phenomena that are explained by it, and if we are able to predict and to make psychological discoveries by means of it, and find nothing to contradict it, it will reach a high degree of probability. When it fails to do this, we must discard it, and substitute another theory.

Validity of Hypothetical Reasoning.—By hypothetical reasoning we can more nearly approximate certainty than by any other process of reasoning whatever. Every great discovery in science has been made in this way. Notwithstanding the great admiration that has been expressed for Baconian induction, no great discovery has ever been made by means of it. The observation of

additional instances according to the Baconian system adds to the probability of the truth of the conclusion in an arithmetical progression. Thus, for every series of x instances we may express the probability of the truth of the Baconian conclusion as x plus x plus x plus x, which equals 4x. By means of the four lines of proof offered for hypothesis, we may have the product of four factors x times x times x times x, or x^4. Hypothesis may not attain a result so certain as complete induction, but complete induction is not reasoning.

Classification.—Classification is another form of reasoning. When we classify any object we put it into a class that has already been formed. Suppose that we are called upon to classify a plant. I examine it and find that it has all the characters that constitute the general abstract notion of Ambrosiaceae, or ragweed family. I classify it in that family. The reasoning process is as follows:

x characters constitute my notion of Ambrosiaceae.
This plant has x characters.
This plant is an Ambrosiaceae.

Such seems to be the process involved in every act of classification, and it demands that we know a good deal about the objects classified. The importance of this process in education is frequently overlooked and misunderstood. It involves, of course, a deductive process, and it is essentially and necessarily a perception of resemblances between the thing classified and the general abstract notion that constitutes the class in which we place it.

Recognition.—Recognition involves a reasoning process. Whenever we recognize a person or a thing as something that has been before seen or heard of or read

about, we do it by a process of reasoning. I saw a man with a peculiar helmet shaped hat riding a bicycle down the street. Half an hour afterward I saw a man riding a bicycle up another street with the same helmet shaped hat. I arrived at the conclusion that it was the same man. The recognition of the hat was immediate. The recognition of the man as the same man necessitated a process of reasoning. The process is a complex one, perhaps too complex to be stated in the form of a syllogism. The major premise involved the immediate recognition of the hat, or some other characteristic. The minor premise involves the assumption that the hat, or other character recognized directly is associated with the same characters that it was associated with before. Then the conclusion is drawn that this is the same man.

Naming.—Naming, or giving a name to an object, involves a reasoning process. A little girl was precocious with her needle. She made doll dresses and was acquainted with the details of ladies' costume. She went out of the house and brought in a ball of snow, which she had scraped off the ledge above the base board. Some one said, "Alice, where did you get the snow?" "O, I got it off the tuck of the house." She applied the word tuck to the ledge, thus giving it a name, and indicating that she perceived a resemblance between this feature of the architecture of the house and the character of a lady's dress to which the name tuck was applied. Whenever we give a name to anything we go through the same kind of a process.

Reasoning Process in Apperception.—Such examples as the one given above are usually employed to illustrate the process which is called apperception, and it shows very clearly what reasoning process is involved in apper-

ception. But apperception is practically only a complex form of perception. It is the sum of all the sensations, both faint and vivid that enter into the percept of an object, with all the related ideas. The perception of the relation is the essential element in reasoning, so that we may describe apperception as a reasoning process.

Reasoning Process in Perception.—But naming itself is scarcely more than perception, and perception involves the perception of resemblance between the qualities of an object. Hence in our most complex process of reasoning we are brought back again to the process of perception. In every process of reasoning we have found that there is the same deductive process, and we shall not be surprised to find in the process of perception itself an exemplification of the first figure of the syllogism, of the mood barbara.

These qualities constitute the apple.
My sensations correspond to these qualities.
My sensations correspond to the apple.

Similarity of All Intellectual Processes.—While the process of reasoning is very complex, and the complexity is indicated by our employment of the words *constitute* and *correspond*, it is possible to show that the process of reasoning and the process of perception involve the same essential elements. So the point at which we have arrived is our study of the most complex processes of the intellect is the point from which we started. The whole intellectual process in all its degrees of complexity resolves itself into the one process of resimilation, or perception of resemblance, and we have a physiological interpretation for that. The perception of resemblance is the concomitant of the transmission of an impulse through the brain cells that are common to two or more cell combinations.

DEFINITIONS

Analogy.—A process of reasoning from a single instance to a general conclusion.

Hypothesis.—A tentative inductive conclusion: A process of reasoning by which we verify an inductive conclusion.

Classification.—A process by which we group an object with those that are like it.

CHAPTER VIII

THE THINKING PROCESS.

There are every year works published whose contents show them to be by real lunatics. * * Take the obscurer passages from Hegel: It is a fair question whether the rationality included in them be anything more than the fact that the words belong to a common vocabulary, and are strung together on a scheme of predication and relation, immediacy, self-relation, and what-not, that has habitually recurred. Yet there seems no reason to doubt that the subjective feeling of the rationality of these sentences was strong in the writer as he penned them, or even that some readers by straining may have reproduced it in themselves.—*James, Vol. I, p. 264.*

The sense of our personal identity is exactly like any one of our other perceptions of sameness among phenomena.—*James, Vol. I, p. 334.*

From our preceding remarks it seems that the nature of mind is its behavior generalized.—*Baldwin, Development and Evolution, p. 274.*

In the unity which embraces and holds together the different ideas and sensations and makes their interaction possible, lies the germ of the conception of the ego, or the self.—*Hoffding, p. 136.*

Thinking.—Thinking is the process of perceiving relations, and we have seen that every relation may be reduced to the single form of resemblance. Thinking, then, is reduced to the process of perceiving resemblances. Every form of thinking may be reduced to this process, and the one common element is found in all. We have described the forms that have been recognized under the names of judgment, reasoning, generalization, and we might include under the same head, perception in its simplest forms. But some examples of thinking that are not commonly recognized as reducible to either of these forms remain to be discussed.

Humor.—In every form of wit or humor will be found this same element of perception of resemblance. A pun is sometimes called the lowest form of humor, and it depends wholly for its force upon the resemblance between the forms of two words, whose meanings are generally incongruous. While the humor, or fun, is a feeling, it is one that accompanies a thinking process, and a resemblance must always be perceived. The point of the joke is in the perception of resemblance, and if the resemblance is not perceived, the point is lost, and the funny feeling is not experienced.

Poetry.—True poetry is an expression of the highest form of thinking. A true poet is one who perceives the relations existing between ideas which an ordinary person, who is not a poet, will fail to discover, and may reach only by a laborious and round-about process of reasoning. These resemblances the poet perceives by a "flash of inspiration," or "poetical insight." This flash of genius, or fire of inspiration has never been sufficiently recognized nor analyzed nor associated with other processes. It consists essentially in the perception of relations which do not appear to the ordinary man. In this respect the poet is like the great mathematical geniuses, or mathematical prodigies who make calculations with lightning-like rapidity, involving the instantaneous perception of relations that are worked out with difficulty by the ordinary man. To Newton, in his eighteenth year, the theorems of Euclid appeared to be self-evident, although most of our high school students arrive at the conclusions only by a difficult process of reasoning.

Genius.—Genius of any kind is manifested by the perception of relations that the non-genius can comprehend only by repetition, slow reasoning, and a long process of

thinking. The genius reaches the same goal by direct route, across lots, that the ordinary non-genius must reach by a roundabout journey. So the true poet, like any other genius, is an example of the highest kind of thinking.

Belief.—Belief arises whenever the relations are clearly perceived. The purpose of reasoning is to lead to the perception of relations; but reasoning is not more likely to induce belief than is any other process by which the relations are clearly perceived. Reasoning has already been described as the psychological concomitant of the process by which a nervous impulse is caused to pass from one brain center into another with which it has no cells in common. It makes no difference by what method the impulse is caused to pass; if the pathway connecting the two centers is sufficiently free, then belief arises. The similarity is perceived. In youth, when the cells are growing and sending out dendrites, and changing their shape and opening up connections with other cells, it is easy to direct the impulse from one center into another, with which in after years the connection would be made with difficulty. This is the psychological and physiological explanation of the fact that early teachings result in beliefs that can seldom be modified or overthrown.

Belief From Repetition.—Repetition will ultimately occasion belief, if the contradictory idea is inhibited, or does not arise. If the thing is asserted a sufficient number of times, belief will inevitably follow. No argument is so convincing as bald assertion, if the assertion is made a sufficient number of times, and the contradictory idea is prevented from arising. This is the psychological principle that lies at the foundation of advertising. Nothing would seem to be more foolish than to repeat the same assertion time after time, but each repetition pro-

duces its effect. Association by coexistence will become as powerful, ultimately, as any other form of resemblance. Given a sufficient number of trials the nervous impulse will pass from one brain center to another, no matter how remote they may be, nor how great the resistance between them is.

Belief From Attention.—Attention is the process by which a nervous impulse may be directed. Resistance may be increased in one direction and diminished in another. Thus attention may hasten the effect of repetition, or even render repetition unnecessary. So we shall come to perceive relations between any two things to which we attend, no matter how unrelated they may at first appear to be. So we shall come to believe in that to which we attend in a proper, positive way, no matter how absurd the thing may be on its face, nor how much it is contradicted by the testimony of the senses. The absurdity of the thing in which the person believes cannot be considered evidence of lack of mental integrity, for the wisest men have advocated most absurd propositions.

Metaphysics.—These facts, that any kind of an association is possible; that any two brain centers may be connected; that the nervous impulse by repetition, reasoning, or early teaching may be induced to pass from any brain center into any other, is sufficient to make us distrust any conclusion that is reached by a process of reasoning alone. In order to justify our faith in any conclusion, we must be able to check it up by facts of the external world and bring it to judgment by scientific means. The testimony of consciousness is always fallible in consequence of the possibility of directing our nervous impulse into any brain center, and arousing belief by the various means suggested. Hence it is that the great

metaphysical systems that have been promulgated from time to time must always be distrusted as systems of ultimate truth, unless they are verified by the means proposed in the discussion of hypothetical reasoning. The fact that no two great metaphysical systems are consonant with each other, but are mutually exclusive, seems to indicate that they will not endure the tests applied to hypothetical reasoning. But that one person is unable to discover any indications of sanity in the system of one philosopher should not indicate to us that the philosopher is lacking in sanity. He sees the relations that he thinks he sees. The difficulty is that another person is unable to cause an impulse to traverse the same route between two brain centers. Hence it is that all metaphysical systems which fail to pass the tests applied to hypothetical reasoning are not likely to have a very high value in developing a scientific conception of the world and the functions of human life in it.

Children's Reasoning.—We are sometimes asked if little children reason. The question is scarcely a proper one until we have clearly stated a definition of reasoning. If we define reasoning as the perception of resemblances, as is done in this book, then of course children reason. The little three and a half year old boy who said "If this (motioning with his hand) is below, then this (another motion) is be up," reasoned as truly as did any philosopher. So the little boy who said to his father, sweeping out an aquarium "What are you brooming it out for?" reasoned very truly. He perceived resemblance between the noun and the name of the action that led him to coin a new word. The evidence that children do not reason is generally derived from the fact that children's actions are sometimes different from those that a grown-up man

would perform in the same situation. The difficulty is not that the child did not reason; but that he did not inhibit his reasoning by the contradictory modifying idea. He reasoned and reached his conclusion too promptly, without delaying his reasoning process.

Unity of all Intellectual Processes.—We see that it is difficult to discriminate a reasoning process from any other intellectual operation. Perception and reasoning are so similar that it is possible to discover the same essential element in the two, and it is difficult to draw the line of separation. It is scarcely necessary nor advisable to separate the intellectual process into its different varieties on the basis of complexity, since the different degrees shade into each other. It is a maxim in botany and zoology that if two different forms of animals or plants are connected by an indefinite number of intermediate forms the two belong to the same species, and to the same line of descent. Applying this principle to the processes of the intellect we shall see that it is necessary to discard all specific distinctions in the intellectual processes.

The Ego, or Empirical Self.—The perception of resemblance is the very core of the idea of personal identity. Every mental process is similar to every other mental process. We should not call them all mental if they were not. But the mental processes of one person are absolutely distinct from the mental processes of another person, and this constitutes the boundary line between different persons, or individuals. The ego idea is obtained, like any other general abstract notion, by the process of generalization, from a comparison of mental experiences. It is no more an intuitive idea than is any other.

Personal Identity.—We have found the physiological concomitant of the element of sameness in mental processes to be transmission of a nervous impulse through the same brain cells that have been traversed before. So we may find the concomitant of the element of sameness that belongs to all mental experiences in the transmission of an impulse in the same circumstance. After a sufficient number of impulses have been transmitted, a sufficient number of brain cells developed and brain centers formed, it becomes practically impossible for a child to have a mental experience that does not involve transmissions through centers, some of whose cells have been traversed before in other combinations. This we may assume to be the concomitant of sameness in all mental processes, and the basis of continuity involved between any series of mental processes and any other.

Alterations of Personality.—As the brain cells change, the identity changes, and the person becomes a different being from what the little child was. Alterations of personality are pathological interruptions of this physiological continuity, and were it complete, the total personality would be altered and a new person developed.

Motives to Action.—Thinking consists in the perception of relations. It may or may not terminate in action. If the relations perceived are those between the individual and some other object, it will in all probability result in action. If the relation perceived is between two terms or circumstances, neither one of which is the individual, no action follows.

Idea as Motive.—Many actions are performed without thought. They are reflexes arising from nervous connections that are already organized in the individual, have

been established by variation, fixed by natural selection, and transmitted by heredity. The motive to an action is the idea of the action itself, or the idea of the result of the action. In order that an idea shall result in action, it must be the idea of that action or of its result. If the idea is an idea of some other kind, it does not constitute a motive to action. When the perception of relations terminates in the idea of an action, then thinking results in activity. Otherwise, thinking does not necessarily do so.

Thinking and Racial Superiority.—The human race holds its position at the head of animated creation in consequence of its greater intellectual power, which is expressed by saying its ability to think, or to perceive relations. Man perceives relations that other animals are unable to discover, and thinking determines the actions by means of which man maintains himself at the head of the animal kingdom. It is thinking that determines what actions will be advantageous to him, and the process results in direct benefit to the individual, preserving him from dangers, or adjusting him better to the situation in which he finds himself placed.

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QUOTATIONS